

Canadian Association of Radiologists Practice Guidelines for Computed Tomography Colonography

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Abstract

Colon cancer is the third most common malignancy in Canada. Computed tomography colonography (CTC) provides a creditable and validated option for colon screening and assessment of known pathology in patients for whom conventional colonoscopy is contraindicated or where patients self-select to use imaging as their primary modality for initial colonic assessment. This updated guideline aims to provide a toolkit for both experienced imagers (and technologists) and for those considering launching this examination in their practice. There is guidance for reporting, optimal exam preparation, tips for problem solving to attain high quality examinations in challenging scenarios as well as suggestions for ongoing maintenance of competence. We also provide insight into the role of artificial intelligence and the utility of CTC in tumour staging of colorectal cancer. The appendices provide more detailed guidance into bowel preparation and reporting templates as well as useful information on polyp stratification and management strategies. Reading this guideline should equip the reader with the knowledge base to perform colonography but also provide an unbiased overview of its role in colon screening compared with other screening options.

Résumé

Le cancer du côlon est le troisième cancer le plus fréquent au Canada. La colonographie par TDM (CTC) constitue une option louable et validée d'examen du côlon et d'évaluation d'une pathologie connue chez des patients pour lesquels la colonoscopie conventionnelle est contre-indiquée ou lorsque les patients choisissent d'utiliser l'imagerie comme principale modalité d'évaluation initiale du côlon. Cette ligne directrice mise à jour vise à fournir un ensemble d'outils pour les spécialistes (et technologues) expérimentés en imagerie et pour ceux qui envisagent d'inclure cet examen dans leur pratique. Elle contient des conseils pour la création de rapports, la préparation optimale à l'examen, des conseils pour la résolution des problèmes afin de parvenir à des examens de grande qualité dans des situations difficiles, ainsi que des suggestions pour le maintien continu des compétences. Nous procurons aussi un aperçu du rôle de l'intelligence artificielle et de l'intérêt de la CTC pour la stadification tumorale du cancer colorectal. Les annexes fournissent des conseils plus détaillés sur la préparation de l'intestin et des modèles de rapports, ainsi que des informations utiles sur la stratification des polypes et les stratégies de gestion. L'étude de ces lignes directrices devrait apporter au lecteur la base de connaissances nécessaire pour exécuter la colonographie, mais aussi fournir une vue d'ensemble non biaisée de son rôle dans le dépistage colique comparativement aux autres options d'examens de dépistage.

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Introduction

Colorectal cancer (CRC) is the third most common malignancy in Canada with over 26,000 cases per annum in 2020. Since 2017, all 10 provinces and Yukon have implemented organized screening programs. Nevertheless, almost half of CRC is diagnosed at stage III or IV, this is paralleled by suboptimal participation, with no program meeting the minimum target of 60% uptake.¹ COVID-19 had a detrimental impact on screening programs, and CRC was no exception. Although CT colonography (CTC) has not been used for mass screening in any province, it remains an integral adjunct to conventional colonoscopy and offers choice to participants who are reluctant or unable to proceed with conventional screening methods.

This paper describes the current state of CTC in the adult population based on the evolving scientific evidence in the field. The Canadian Association of Radiologists last provided guidance on CTC in 2010.² The following practice update offers recommendations and minimum standards for the acquisition, interpretation, reporting, and maintenance of competence in CTC, along with a tool kit for radiologists and technologists who are performing or embarking on CTC in their practice. A sample reporting template is provided in [Appendix 1](#).

Role in Screening

Screening CTC identifies entirely asymptomatic individuals with polyps or cancer. CTC is safe, well tolerated, and accurate for the detection of CRC and large polyps ([Table 1](#)). A recent systematic review demonstrated the rate of interval cancers following negative CTC (4.5%) favorably compares to that following optical colonoscopy (OC) (3-9%).⁹ OC is the primary investigation of choice in population-based screening for colon cancer, with CTC an excellent option in select cases.

In general, CTC should be offered for screening every 5 years after the age of 50 if optical colonoscopy is medically contraindicated, technically challenging, or incomplete.¹⁰⁻¹⁴ Patient preference may also be a reason to choose CTC. Some data suggests that individuals at low and moderate risk of

colon cancer can be screened with CTC, while high-risk patients should be screened with colonoscopy where possible.¹¹

There is extensive published evidence in support of the reliability of CTC for screening for CRC. For example, a study showed that CTC identified 90% of adenomas or cancers measuring 10 mm or more in diameter.¹⁵ Validation trials in screening cohorts and subsequent meta-analyses have demonstrated high sensitivity,^{11,16} often exceeding OC, with no missed cancers.³ Randomized controlled trials in Europe evaluated CTC as the primary test for population screening of CRC, compared to fecal immunochemical test (FIT), sigmoidoscopy and OC. The detection rate of CTC for CRC and advanced adenomas was 5.1-6.1%.¹⁴

The Value of CTC in a Screening Paradigm

A Canadian study showed it is feasible to run a high-volume CTC service, reducing the requirement for optical colonoscopy in over 70% of patients, confirming that CTC is a valuable triaging tool where long OC waitlists exist.¹⁷ The participation rates for screening CTC are higher than for optical colonoscopy.^{14,18} Therefore, despite a slightly lower detection rate of polyps with CTC than with colonoscopy, the detection rates per patient of CTC and colonoscopy are comparable. The higher participation rates also render CTC more cost-effective, justifying the inclusion of CTC in organized screening programs for CRC.

Indications for CTC

Indications for CTC examination will vary but generally, CTC is offered for patients over 50 who are either asymptomatic or with symptoms potentially attributable to colorectal cancer ([Table 2](#)).¹¹

Screening

CTC plays an important role in screening for colorectal neoplasia. European guidelines recommend CTC as an

Table 1. Detection Rates of Screening Tests for Colorectal Cancer.

Screening Test	CRC Detection Rate (%)	Advanced Adenomas (%)
CTC	96 ⁹	67-94 ¹⁰ (>10 mm) 73-98 ² (>6 mm)
OC	95 ⁹	88-98 ¹⁰ (>10 mm) 75-93 ¹⁰ (>6 mm)
FSIG	58-75 ^{11,12}	77-86 ^{12,13}
FIT	73-96 ¹⁰	22-40 ¹⁰
FIT-DNA	92 ¹⁰	42 ¹⁰
mSEP9 DNA	48 ¹⁴	11 ¹⁴

Table 2. Indications for CTC.

Screening • Asymptomatic average risk • Asymptomatic with positive family history • Asymptomatic with risk factors for OC • Patient declines OC	Diagnostic • Incomplete colonoscopy (same day or remote) • Problem-solving following OC • Unexplained GI symptoms, anaemia or GI bleeding • Surveillance of 6-9 mm category lesion • Evaluation of colon proximal to an obstructing lesion/neoplasm • Staging of known neoplasm and exclusion of metachronous lesions • Surveillance following prior colonic resection for cancer/polyps
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acceptable alternative to colonoscopy in the screening population.¹⁹ The US Preventative Services Task Force reports that CTC accuracy is similar to OC for identifying adenomas ≥ 6 mm.⁴ The Canadian Association of Gastroenterology supports CTC for screening average-risk patients in select cases.¹⁰ Provincial reimbursement varies with regards to CTC in the screening context however where patient choice or medical contraindications (Table 3) warrant the examination there is a clear justification for the procedure to be performed.

Incomplete OC

CTC is a critical tool in the evaluation of patients with signs and symptoms suggestive of colorectal cancer for whom OC is incomplete or contraindicated due to an occlusive tumour or patient factors (incomplete bowel preparation, anatomical factors, patient discomfort, sedation risk, severe co-morbidities). Almost all incomplete studies performed with lumen-occluding lesions can be interrogated on CTC. As many as 35.1% of synchronous lesions occur in 1 or more segments away from the offending lesion and the depiction of these significantly impacts patient management.

Synchronous CRC prevalence is reported at 5.7% (95% CI 4.7%–7.1%),²⁰ highlighting the key role CTC plays in preoperative evaluation of the entire colon. Identification of synchronous lesions can alter patient management in up to 21.5% of patients with an occlusive CRC and incomplete colonoscopy.²¹

Contraindicated OC

CTC is a useful and appropriate tool for patients who have a contraindication (absolute or relative) to OC. In the event of a significant finding, the patient should be counselled that subsequent OC may be required.

Signs or Symptoms of Colorectal Cancer

CTC plays a role in evaluation of patients with signs and symptoms suggestive of colorectal cancer for whom OC is incomplete or contraindicated. CTC^{20,21} and OC have similar sensitivity (93% vs 92% respectively) for detecting CRC in patients over 65 years,¹⁶ and large polyps in symptomatic patients.²²

Post-Operative

CTC is indicated in patients after hemicolectomy for whom OC is contraindicated or unfeasible. Patients should be informed that CTC is inferior to OC in detection of polyps in this setting, with a sensitivity of 44.0% for polyps ≥ 6 mm and 79.6% for polyps ≥ 10 mm.²³

Other Clinical Scenarios

Patients with a history of prior colon cancer or neoplasia can undergo CTC if there is a contraindication to OC. In this setting, it offers a one-stop shop for restaging and colonic assessment.

Safety

CTC and colonoscopy are both associated with low risk of perforation, although lower with CTC. Meta-analyses published in 2014 and 2016 report rates of perforation of .04% in CTC²⁴ and .5% in colonoscopy.²⁵ Further, the overall risk of perforation is higher in symptomatic/diagnostic individuals compared to those undergoing screening.²⁴ Most perforations are treated conservatively.^{24,26}

Risk factors for perforation include manual insufflation with room air or an inexperienced operator, recent colonoscopy with polypectomy, older patient age, inguinal hernias containing colon, diverticulosis, or obstructing neoplasm.^{27,28} CTC can be performed after a colonoscopy with polypectomy, although many authors advocate waiting 2–4 weeks.^{27,29} Risk can be further mitigated post-colonoscopy with a low-dose non-contrast CT before insufflation to exclude a clinically-occult perforation.¹² Minor adverse events such as vasovagal reactions are also rare and self-limited.^{27,30,31} Radiation exposure with CTC is small, with the estimated number of CRCs prevented with a 5-year screening interval outweighing the number of radiation-induced cancers (benefit-risk ratio of 24:1).³² While there is variation in effective dose between institutions, CTC doses are now lower than reported in this study.³³

With advances in CT technology, such as iterative reconstruction and lower tube voltage, CTC effective doses have been reported as low as sub-millisievert level.³⁴ Iodinated IV contrast is not typically administered for CTC. However, if administered, there is a very low risk of iodinated contrast

Table 3. Contraindications for CTC.

Clinical Scenario	Comments
Fulminant colitis	Any acute inflammatory condition increases propensity for perforation
Symptomatic acute colitis	
Acute diverticulitis	4-6 weeks after acute episode. Risk of perforation is low quoted at 1-5/1000 ²⁴
Recent colorectal surgery	Recommendations suggest wait time of 4-6 weeks post-surgery
Colon containing inguinal hernia	This is a relative contraindication; ensure the hernia is reducible prior to the study
Recent deep endoscopic biopsy or polypectomy	Variable guidance with regards to timing. Safe recommended interval varies between 2-4 weeks. If there has been endoscopic mucosal resection (EMR) for instance (with flat lesions) and lesion is proximal suggestion is to stay closer to the 4-week interval. Left sided polypectomy on the other hand 2 weeks may be sufficient ⁶
Symptomatic or high-grade bowel obstruction	
Hereditary polyposis or non-polyposis syndromes	
Inflammatory bowel disease	This is a relative contraindication as CTC does not have utility for screening in this patient population due to the risk of dysplasia and cancer in the setting of longstanding IBD, however it may be used for problem solving (for instance in stricturing disease as long as the limitations are discussed with the referring GI.

Adapted from ACR-SAR-SCBT practice parameter for the performance of CTC in adults.²⁶

media reactions, (for example anaphylaxis), contrast-associated acute kidney injury,³⁵ and hypersensitivity.³⁶

Benign colonic pneumatosis is seen in approximately .11% of patients and has a predilection for the right colon.³⁷ The patients are usually asymptomatic. Radiologically, there is intramural gas but no free air or extrinsic to the colonic wall. This phenomenon has only been described with CO₂ insufflation.

Extracolonic Findings

One of the common criticisms levelled at CTC is the detection of extracolonic findings (ECF). To reduce undue patient anxiety, cost and unnecessary further investigations, ECF should be stratified from clinically unimportant (E2) to potentially important findings (E4) as per CT Colonography Imaging Reporting and Data System (C-RADS).³⁸ (Appendix 2). Although up to 70% of CTCs may produce extracolonic findings, the majority of these (84-88%) are insignificant/normal variants (E1) or unimportant/benign, not requiring further work up (E2).³⁹ Potentially significant ECF (E4) are more frequently identified in older and symptomatic patient populations.⁴⁰

Apart from CRC and advanced adenoma detection, CTC offers an opportunity for limited screening of the lower thorax, abdomen and pelvis. Up to 4.0% of potentially important ECF (E4) represent malignancy³⁹ (most commonly RCC, lung, and lymphoma). The findings that may warrant further investigation (E3) or are potentially clinically significant (E4) include extracolonic malignancies, abdominal aortic aneurysms, or undiagnosed pathologies such as urolithiasis and chronic liver disease. Artificial Intelligence offers an opportunity to improve the accuracy of incidental extracolonic lesion characterization as well as opportunistic screening for extracolonic pathology.

Though the shift from conventional to low-dose CTC has reduced sensitivity in detecting potential ECF, recent meta-analysis demonstrates that potentially significant ECF (E4) are identified in up to 5.2% of symptomatic and 2.8% of asymptomatic patients, with recommendations for further investigations in up to 8.2% of all patients.⁴¹ Referring clinicians should be aware of the current paradigm for low-dose CTC and be cognizant of the downstream impact on the detection of extracolonic findings. Reports should acknowledge diminished sensitivity.

Ultimately, opportunistic screening of asymptomatic populations for ECF (outside the spectrum of malignancy) has a dual advantage as it maximises the cost-effectiveness of this examination. Potential areas include osteoporosis, abdominal aneurysm screening and fat quantification.

Flat/Serrated Lesions

Serrated polyps represent an alternate pathway to the development of colorectal cancer and likely account for 15-30% of sporadic non-familial cases.^{42,43} The WHO has subclassified serrated lesions into hyperplastic polyps, sessile serrated lesions (SSL), SSL with dysplasia, traditional serrated adenomas (TSA) and unclassified serrated adenomas.

SSL with and without dysplasia are superficially elevated lesions >3 mm in height relative to the normal mucosa with a plaque-like morphology and have a risk of malignant transformation. These lesions can be subtle with minimal protrusion into the lumen. They have a propensity for the proximal colon and are usually larger (>10 mm). Prevalence of these lesions in asymptomatic Western populations is estimated at around 3.1% for the larger lesions.⁴⁴ There is a wide variation in reported prevalence due to lack of consensus on the

definition, detection strategies and histopathologic assessment.⁴⁵ A small proportion of these lesions (Type IIC = central depression) are more aggressive than their counterparts; this risk has been incorrectly assigned to all flat lesions.

Awareness of their typical morphology and location can help improve diagnostic accuracy in the detection and reporting of these lesions. Concurrent improvements in technique have resulted in improved detection rates at CTC. Emerging data shows many of these lesions have an indolent natural history with many showing little or no progression at follow-up CTC studies. Older studies have shown inferiority in detection of flat lesions relative to conventional polyps. Unlike traditional polyps, sessile lesions are risk-stratified by morphology,⁴⁶ and not by size alone (Appendix 3).⁴⁷

Colonic distension is an important prerequisite for polyp detection, however, readers need to be aware of the impact of distension on the minimal profile of sessile lesions.⁴⁸ The so-called “disappearing phenomenon” can further diminish lesional conspicuity. The presence of adherent contrast, as well as concurrent confirmation of a fixed location on both 2D and 3D are invaluable methods of detection. Lack of tagging may contribute to their inferior detection on CTC relative to OC.⁴⁶ A recent study (N = 7940) demonstrated that CTC with a 6- and 10-mm threshold had a higher yield and positive predictive value for the high-risk SSLs as compared with non-invasive testing such as mt-Sdna.⁴⁵ PPV and overall screening yield for high-risk SSLs were 5.5% vs 14.4% and .7% vs 1.7% for mt-sDNA vs CTC at a 6 mm threshold, respectively (both $P < .001$).

Polyp Management Strategy

Conventional polyps follow an adenoma-carcinoma pathway, lending themselves to a screening program. This is a multi-step process with a series of sequential accumulation of gene mutations. The risk of malignancy increases with increasing polyp size³⁶ (Table 4). However, in addition to size, features such as lesion and morphology can help prognosticate significance. For instance, pedunculated lesions are typically larger and more likely to have underlying tubulovillous or villous histology.

30-40% of the population will develop an adenoma by age 60,⁵⁰ and risk of developing colorectal cancer increases with

age, particularly between 60-70 years of age.⁵¹⁻⁵⁴ The lifetime cumulative risk of developing cancer is 5.5%.⁵⁰ However, the natural history of polyps is not always predictable nor step-wise, and not all colonic adenomas progress to malignancy. 15-20% of cancers arise via an alternate pathway where size is not the determinant of risk.

Despite these 2 pathways, it is widely acknowledged that the dwell time for this progression is likely a decade or more. Awareness that selective polypectomy is more cost-effective and results in wiser utilization of limited resources with a lower incidence of complications is an important paradigm shift; it is a divergence from the gastrointestinal approach of universal polypectomy (Figure 1).

Traditionally, polyps >1 cm and cancers are triaged to immediate polypectomy. The management of lesions in the 6-9 mm category is variable and will be informed by local policy (as discussed with GI), patient preference and individual risk factors. For example, medium and even large polyps are frequently not referred for polypectomy if the risk for conventional scope appears to outweigh the potential benefit.

CTC with a selective polypectomy strategy is the most cost-effective method of performing CTC and compares favorably with conventional scopes when this strategy is employed.^{55,56} Additionally, natural history data shows mid-size polyps can be safely observed, with a least 20% of lesions in this category showing net regression.⁵⁷ Moreover, CTC confers the benefit of observing volumetric (and not linear) threshold for growth as well as proving an accurate localization of location and morphology.⁵⁸

Artificial Intelligence

Vendor specific recommendations are beyond the scope of this document but we urge readers to try out colon software prior to purchase to personally assess performance, characteristics and range of plug in options (e.g., CAD) prior to committing to a product. Commercially available computer-aided diagnosis (CAD) tools are based on second-era machine learning which was developed prior to wider access to deep learning tools. Deep learning has enabled the learning and linking of patterns in datasets and allows for the creation of more robust

Table 4. Risk Stratification According to Polyp Size.

Polyp Size	Prevalence (%)	Risk of Advanced Histology*	Risk of HGD	Risk of Cancer
All polyps ≥ 6 mm	14			
<5 mm		.3-1.2%	.3%	0%
6-9 mm	8	2.9-5.3%	.8%	0%
>10-20 mm	6			1% or less (5-10% in older literature)
>20 mm		Up to 50%		

*Advanced histology refers to lesions with (villous component, HGD or invasive cancer).⁴⁹

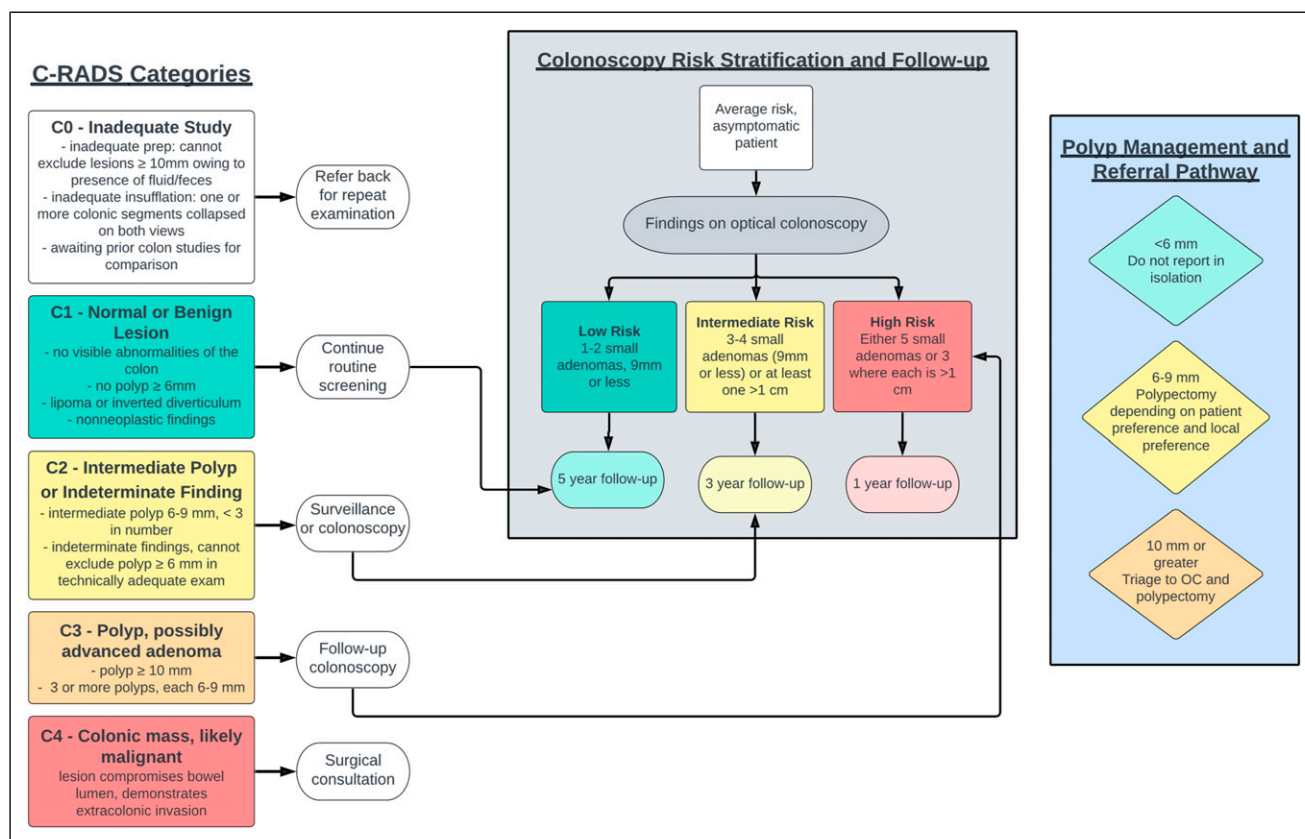


Figure 1. Correlation between C-RADS categories and risk stratification based on endoscopic findings, with guidance for follow-up intervals.

solutions. These are more commonly referred to as Artificial Intelligence (AI).⁵⁹ CAD tools/plugins are offered by most vendors on their 3D visualization platforms; however, their role in a routine workflow is less well established. CAD tools as a second reader have been shown to improve reader sensitivity, especially for less experienced readers,⁶⁰ but also led to reduced specificity and an increase in false positives in those studies. Studies have shown that comprehensive training can result in performance akin to that of CAD as a second reader.⁶⁰

However, current research shows that AI/ML tools have the potential to improve detection of clinically significant polyps and overcome some of the shortcomings of CAD tools.⁶¹ A proof of concept study showed deep learning could discriminate pre-malignant from benign polyps on CT and therefore identify the subset of patients who would benefit from endoscopic polypectomy. AI tools allow for improved image reconstruction of low-dose CT acquisitions.⁶² An exciting area for AI/ML applications is opportunistic screening for osteoporosis, vascular aneurysms, coronary artery disease, visceral fat and metabolic syndrome, and sarcopenia.⁶³⁻⁶⁵ Future AI/ML research may also improve the characterization of incidental extracolonic findings; however, there are no current active projects in this space.

Role in T Staging

Accurate T staging is an important prognosticator in the pre-treatment setting of colorectal cancer. Preoperative staging impacts surgical approach and the extent of nodal dissection. Clinical trials such as the FOxTROT⁶⁶ and PRODIGE-22⁶⁷ have shown the merits of pre-operative chemotherapy in high-risk patients (T3 and T4). Overtreatment remains a concern and accuracy of T staging is paramount in stratification. Accuracy of conventional CT remains suboptimal. Despite the advent of multi-detector CT, accuracy of T staging for colorectal cancer is 73% if axial images were assessed alone and improved to 83% when interpreted in the setting of multiplanar reconstruction (MPR). Pre-operative T staging by CTC with MPR shows improved diagnostic confidence in discriminating between T2 and T3 disease as neoadjuvant therapy is indicated in the context of the higher-risk lesions. A prospective study of patients with colon cancer who underwent CTC pre-operatively showed an accuracy of 87.1% in discriminating T1/T2 vs T3/T4 tumours, with high sensitivity (88.5%) and specificity (84.1%). For high-risk tumours (T3 ≥ 5 mm and T4), CTC showed an accuracy, sensitivity, and specificity of 82.7%, 86% and 80%, respectively (kappa = .65).⁶⁸

Imaging criteria based on the spatial relationships of tumours and the bordering vessels (both marginal and subserosal) are useful in distinguishing T3 from T2 and T4 disease.⁵⁸

One of the strengths of CTC is being able to screen the entire colon even in the setting of stricturing or obstructive lesions. In this scenario, a diagnostic enhanced study in the portal venous phase, with optimized MA and kVp is performed as the second acquisition (supine series by convention). The parameters are lower for the non-contrast series. Even at low dose, unenhanced CT can evaluate the colon wall deformity and fatty infiltration demonstrating serosal involvement.

Utilization in Times of Stress in Healthcare

To date, CTC has not been used in population-based screening due to availability, cost, expertise, and concern with regards to widespread implementation. The recent COVID-19 pandemic has reinforced that exposure-prone procedures including upper and lower GI endoscopy can be heavily impacted at times of stress on the healthcare system. There is modelling data showing that even transient interruptions to screening can impact the numbers of individuals whose CRC diagnosis is delayed or worse not made with impact on overall patient outcome.^{69,70} Prioritization tools have been suggested to triage the small subset of patients who do need endoscopic intervention. CTC is 1 such method that can allow noninvasive, risk-free screening and help minimize wait times.

Bowel Preparation

Bowel preparation⁷¹ is crucial for a successful CTC examination, affecting sensitivity and performance for the detection of pathology (Appendices 4 and 5). A low residue diet may be required, especially for patients with poor preparation or refractory constipation. Preparation involves a cathartic agent (laxative) and a tagging kit, with a low-volume, iso-osmolar cathartic being preferred. The agent should be safe for patients with fluid restriction, cardiac issues, hepatic or renal insufficiency. Dry regimens with hyper-osmolar agents have higher patient acceptance and leave less residual fluid. Factors such as patient preference, medical comorbidities, and prior reactions influence the choice of agent. The preparation should leave the lumen clean and dry, and a 1-day prep is well tolerated and effective for most patients.⁷² Although residual fluid in the lumen can be easily managed on OC by suction, this is not an option on imaging; moreover, patient tolerance is low.⁷³

The tagging kit comprises a 2% w/v barium solution and an iodinated contrast agent gastrografin (diatrizoate) or iohexol are 2 options.⁷⁴ Tagging helps distinguish polyps or cancers from soft tissue density and improves reader performance, with less reliance on dual positioning for diagnosis. The tagging incorporates contrast into any residual fluid (iodine) or fecal material (barium) and has a secondary cathartic impact.⁷¹

The material can be electronically subtracted from the lumen using a thresholding algorithm.⁷⁵

The by-product of tagging is the coating of the ingested contrast to the surface of polypoid lesions (both sessile and convex lesions). This phenomenon is related to the presence of altered mucoproteins resulting in adherence of contrast material on the surface of polyps.^{76,77} This also improves lesional conspicuity and diagnostic performance. An awareness of the impact of tagging in terms of artifact on 2D imaging (beam hardening at low kVp) as well as subtraction artifacts on 3D images is important, but beyond the scope of this guideline.

Non-cathartic or prepless examinations are not the preferred method when polyp detection is the desired outcome. However, there is a sufficient body of evidence to indicate this technique has a role to play in the exclusion of cancer/large polyps in older/frail patients³¹ for whom a full bowel preparation may be contraindicated or technically unfeasible. A study utilizing only gastrografin prep showed a very high NPV of .99 for exclusion of CRC.⁷⁸ DECT may potentially impact the quality of non-cathartic CTC as artifacts typically associated with electronic cleansing are not seen in this technique. A dual energy index can aid discrimination of air, fecal tagged material from soft tissue density lesions.⁸¹ When reading an examination where preparation is suboptimal a 2D approach may be necessary for segments where assessment is limited by the presence of stool/residual material. A comment in the report that sensitivity is limited and confined to detection of larger polyps or masses may also be appropriate.

For same-day CTC following incomplete colonoscopy we recommend 30 mls of ionic water-soluble iodinated contrast.⁷⁹ This is administered orally once the patient is fully recovered from sedation. A minimum of 2-3 hours wait is preferred to allow adequate opacification of any untagged fluid. In a study with a 2 hour wait time, there was failure to reach the left colon in 26% of patients.⁷⁹ This may not be an issue where the left colon has been adequately seen on OC. There are studies showing longer wait times improve homogeneity, performance of flat lesion detection and degree of tagging⁸⁰ but for scheduling and patient-related factors, this may not be a viable option.⁸¹

Technique

Colonic Insufflation

Before the examination, it is prudent to ask questions about compliance with the bowel preparation and tagging regime. Success is usually indicated by passage of clear or yellow stained fluid. If the patient is still passing solid stool additional preparation may be needed (Appendix 5e-f).

The colon should be evacuated prior to insertion of a soft tip lubricated rectal tube. The tube should be inserted by trained staff members familiar with anatomy and potential limitations to insertion (eg, perianal disease, hemorrhoids, post-surgical changes). Mechanical insufflation with carbon

dioxide is the only acceptable method and is proven to have a better safety profile and tolerance. 2 L of carbon dioxide are usually administered at target pressure of 20-25 mmHg after which a scout image is obtained in the initial position.^{82,83} Adequate distension should be confirmed by the presence of a continuous column of gas throughout the colon and can be assessed by either the radiologist or a trained delegate. A minimum of 4 L is generally needed for adequate distension, but this volume can vary due to patient anatomy, sphincter control and reflux via an incompetent ICV. The amount of gas can be increased as needed to achieve adequate insufflation (Appendix 6). Inflation of a rectal balloon is controversial;⁸⁴ some institutions routinely inflate it irrespective of sphincter competence but will obtain a second series with the balloon deflated to avoid obscuration of anal pathology. Troubleshooting insufflation and other factors may be required (Table 5).

In the post-operative scenario CTC is technically feasible in the setting of a colostomy (e.g., following APR). We recommend inserting the Foley catheter several centimeters beyond the cutaneous surface to avoid the risk of balloon expulsion while inflating with CO₂. Modifications to image

acquisition include substitution of a prone series with a decubitus for obvious reasons.⁸⁵ In the setting of an ileostomy the examination may be more technically challenging. In both scenarios a modification to bowel prep is needed. Patients with ileostomies are susceptible to dehydration and electrolyte disturbance and require a clear fluid preparation only (No cathartic), with a colostomy a split preparation is often needed. Both scenarios offer the opportunity for a “1 stop shop” in the surveillance of colorectal cancer.

Antispasmodics

Hyoscine Butylbromide (Buscopan), can be used to improve colonic distention and increase patient comfort during the examination. One study found that Buscopan improved colonic distention significantly for CTC and administering Buscopan had an odds ratio of 6.49 for adequate colonic distention throughout all colonic segments compared to patients who did not receive it.⁷¹

When administered, patients should be pre-screened for any potential contraindications, including acute coronary syndrome, uncontrolled cardiac failure, and arrhythmias, and

Table 5. Troubleshooting the CTC exam.

Scenario	Causes	Solution
Air will not insufflate	Obstruction to tube	• Check tubing is it kinked or blocked?
Scout shows no/minimal air in colon	Check if air is leaking (incompetent sphincter)	• Inflate balloon or tape tubing
	Obstruction in lumen	• Consider intrinsic pathology such as a stricture or mass. Fluid in the lumen may also preclude distension and should be drained
Solid stool in lumen	Poor compliance or response to prep. Underlying obstructive lesion?	• Check images* and talk to patient
		• If compliance or response to prep is the underlying cause
		• Rebook: Use an alternate/additional prep and/or consider an additional day of clear fluids
		• If structural: may have to interpret as best as possible
Patient habitus	Pannus may result in suboptimal distension in the standard views	• Suggest routine utility of 2 decubitus views
	Increased noise on images	• Tailor mA to patient size
Reflux of air into the small bowel or stomach	Incompetent ICV	• This is not reversible. The aim should be to achieve the best possible colonic distension whilst eliminating patient discomfort from the increasing global bowel distension
	Buscopan induced incompetence	• Consider routine use of Buscopan in patients with severe diverticulosis
Colonic spasm/severe diverticulosis	Muscularis hypertrophy in severe diverticular disease	• Employ decubitus view to assist in distending a collapsed segment
Collapsed segment	Sporadic peristalsis	• Patient encouraged to evacuate routinely prior to exam
Residual colonic fluid (in large volumes)	Type of prep	• Empty tubing if excessive fluid present
	Excessive intake of fluid the night prior (by patient)	• Use gravity to move column of fluid and allow insufflation
Inguinal or ventral hernia**		• Monitor carefully during insufflation and ask patient to palpate during this time and self-report any unexpected pain
		• Decubitus views are invaluable in ventral hernias
Lack of tagging	This may not always be apparent on scout even if present	• Ask patient if they took it
		• If not consider deferring exam by 2-4 hrs. (If scheduling permits) and administer tagging

*We recommend getting a few slices to assess adequacy of prep as the scout may be misleading.

**Relative contraindication: ensure the hernia is reducible prior to the study.

should be withheld in these situations. Screening for glaucoma is a misnomer and technologists or nursing staff must receive adequate training to recognize contraindications and potential side effects of Buscopan as well as awareness to counsel patients for potential precipitation of acute glaucoma.⁸⁶ Side effects include urinary retention, dry mouth and blurred vision. Patients are counselled about these and advised not to drive following the procedure if they receive Buscopan.⁷¹ Glucagon is a viable alternate to Buscopan in the setting of contraindications. Published data shows inferiority to Buscopan,⁸⁷ and its higher cost and less favourable side effects profile ensure it less commonly utilized than Buscopan.

Image Acquisition and Post Processing

- The images are acquired as a single breath hold with coverage of the entire colon and rectum as guided by the scout images.
- Use a low-dose, non-enhanced CT with dose adaptation based on the patient's body habitus.
- Target a CT Dose Index Volume (CTDI_{vol}) of 5 mGy or less per acquisition, or a Dose Length Product (DLP) of 600 mGy.cm or less for the whole exam.^{88,89}
 - This can be achieved by setting the tube voltage to 120 kVp and using automatic dose modulation with a reference tube current of 35-70 mA, or a minimum/maximum tube current 40 mA and 450 mA respectively.
 - Titrate parameters based on the patient's body habitus to ensure diagnostic image quality.
- Employ dose reduction techniques such as optimum positioning, automatic exposure control, and deep-learning image reconstruction.
- Acquire thin section images (.6 – 1.5 mm) using a soft-tissue reconstruction algorithm.
- View images on a workstation or as 2D multiplanar reconstructions, 3D intraluminal views, or both.
- Optional: use digitally cleansed images.

Patient Positioning

The entire colon should be imaged in a minimum of 2 positions, ensuring adequate distension and utilizing any combination of supine, prone and decubitus techniques. Patient preference and anatomy can influence choice; in larger patients, in the setting of hernia(s) or a stoma a decubitus is invaluable. Similarly, the right lateral decubitus position⁹⁰⁻⁹⁶ is helpful for problem solving in patients with diverticulosis of moderate or greater severity.

IV Contrast

IV contrast is not used for routine screening CTC, only for staging CTC (in the setting of a known mass/neoplasm) or problem solving. The low-dose, alternate position should be

acquired first to reduce artifacts from contrast being excreted into the ureters and urinary bladder.

It should be administered in the supine position thereafter and a standard technique (full dose) CT of the abdomen and pelvis should be acquired.

Dual Energy CT

Dual Energy CT (DECT) can improve subtraction of contrast material on virtual non-contrast images compared to electronic cleansing. Improved detection of polyps on virtual mono-energetic images has also been reported. DECT may also offer improved image quality due to the benefits of greater contrast from the low-energy images and reduced noise from the high-energy images.

Contrast-enhanced DECT may alleviate the need for bowel cleansing and fecal tagging while still offering high sensitivity and specificity for the detection of polyps, which would potentially improve patient acceptance of CTC as a screening modality.⁹⁰⁻⁹⁶

Quality and Safety Check

Following image acquisition, CT technologists should be adequately trained to recognize under distension and acquire additional images prior to discharging the patient. A safety check should include assessment for any potential perforation or extra-luminal air prior to discharge from the department.

Patient Preference

CTC leads to higher patient satisfaction^{97,98} and better screening compliance than colonoscopy.⁹⁹ Of CTC patients who had a prior colonoscopy, 77.1% preferred CTC and 13.8% preferred colonoscopy.⁹⁸ Preference for CTC is attributed to its minimally-invasive nature, limited bowel preparation, non-sedation and low risk of complications compared with colonoscopy.^{98,100} CTC is convenient, with 37% of patients saying they wouldn't have screened otherwise.¹⁰⁰ In post-operative patients, however, preference for colonoscopy was higher (42.6%) with no preference for 35.4%. In 1 study, only 3% of CTC patients experienced significant pain compared to 34% during colonoscopy; polyp detection shifted preference to colonoscopy.¹⁰¹ In a comparative trial, participants expected colonoscopy to be more burdensome, but found CTC more burdensome after the procedure.¹⁰² Use of carbon dioxide for colonic insufflation results in less pain and bloating compared to room air insufflation. CO₂ usage in colonoscopy leads to less post-procedure discomfort and less retained colonic gas.¹⁰³

Cost-Effectiveness

The cost of a screening test such as CTC is often compared with the gold standard of OC. The average cost of a

colonoscopy varies widely across international jurisdictions. In the Canadian setting, CTC compares favorably against OC when a rationalized referral approach is adopted (≥ 6 mm).

The cost-effectiveness of a screening test is also dependent on rate of participation as well as the numbers of screening rounds. The COCOS trial showed CTC was the most cost-effective strategy in participants who underwent >2 lifetime screens and was the preferred test by participants.¹⁸ A recent Canadian study suggests that increasing the screening interval to 10 years would increase the cost-effectiveness of CTC.¹⁰⁴ However, the study failed to address several important considerations including patient compliance (higher in CTC) and the time commitment (both by the patient and their accompanying friend/family) when sedation is given. This loss of time also contributes to the overall economic burden imposed by OC and the authors acknowledge this likely undermined the true cost effectiveness of CTC.

Training and Certification

Recommended Requirements

- Physician with specialist training in diagnostic radiology and abdominal CT, equivalent to Royal College curriculum, is required.
- Basic training in virtual colonoscopy, including didactic training and buttonology, should be completed with review of 50 cases with endoscopic correlation.
- Cases should showcase a range of colonic pathology and complexity and include a mix of contrast and non-contrast techniques.
- During training, the review process should use dedicated CTC software with instruction and supervision, including reporting and interpretation.
- Double-reading and self-audit with endoscopy feedback is suggested. Awareness of 7-12% positive findings in average risk population helps benchmark referral rates for follow-up endoscopy.

Rationale

Various national and international bodies have published recommendations and benchmarks for radiologist training prior to independent reporting of CTC, though the minimum standards and suggested training methods vary.¹⁰⁵ (Appendix 7). The minimum standard is 50 pathology-proven cases with a spectrum of pathology, but there is limited detail about requirements for the spectrum of complexity assessed in these cases, nor are there stated requirements for PPV or polyp identification rates.

There is evidence that training in CTC interpretation incrementally improves reader sensitivity and performance with the number of cases read,¹⁰⁶ but reading a pre-determined number of cases is not a guarantor of performance.¹⁰⁷ Training and feedback are important components of diagnostic

performance in addition to clinical experience. Studies which have focused on delivering feedback to readers, with or without tailored individualized training, have demonstrated significant gains in reader sensitivity.^{106,108,109}

Maintenance of Competence

Maintaining the quality of CTC reporting is imperative to the credibility of the technique and will minimize perceptual errors when interpreting these exams. This in turn influences polyp or cancer detection and directly impacts patient outcome.¹⁰⁸

As of 2019, the ACR recommends a 50-case review with endoscopic correlation every 2 years.⁸⁸ Ideally, a periodic audit of all exams including endoscopic feedback and internal peer review process will help facilitate this ongoing learning and maintain reader sensitivity and performance. The CAR recommends that the latter is a more feasible and realistic approach in the Canadian context. This audit should be performed every 3 years as a minimum.

We recognize that this may be a challenging number to achieve in some centres. Possible solutions to increase reader volumes include:

1. Restricting CTC reading to those with expertise/interest in the area.
2. Continuing to double read to gain mutual experience and feedback.

Conclusion

CT colonoscopy is a mature technology with proven value add to the paradigm of colon cancer screening and problem solving in colonic pathology. Understanding its strengths and limitations in this regard equips the performing radiologist with a powerful tool to facilitate patient choice and provide a desirable outcome.

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Disclaimer

CAR Clinical Practice Guidelines are based on evidence review and consensus recommendations derived from the available evidence at the time of preparation. The guidance provided herein should not be utilized to establish a legal standard of care and should be interpreted in the setting of specific clinical situations and resource availability. Adherence to the guidance cannot assure an accurate diagnosis or a

successful outcome. Deviation does not, in and of itself, indicate or imply that such medical practice is below an acceptable level of care. The ultimate judgment regarding the propriety of any specific procedure or course of conduct must be made by the physician and imaging care team considering all circumstances presented by the individual situation.

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Supplemental Material

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Appendices to the

Canadian Association of Radiologists CT Colonography Guideline



Table of Contents

Appendix 1: Sample Reporting Template	3
Appendix 2: C-RADS™ Categorization and Management Recommendations for Colonic Findings.....	4
Appendix 3: Paris Classification.....	5
Appendix 4: Bowel Preparation Methods.....	6
Appendix 5: Patient-Facing Materials	7
5a: Appointment Info Sheet for Patients.....	7
5b: Exam Info Sheet for Patients.....	8
5c: One-Day Prep Instructions for Patients	9
5d: One-Day Preparation Checklist for Patients.....	11
5e: Three-Day Prep Instructions for Patients.....	13
5f: Three-Day Patient Prep Checklist	16
Appendix 6: Recommended method of colonic distension.....	18
Appendix 7: Comparison of International CTC Interpretation Training Guidelines for Gastrointestinal Radiologists.....	19
Appendices References	20

Appendix 1: Sample Reporting Template

CT Colonography (Virtual Colonoscopy)

CLINICAL HISTORY: [HISTORY]

CT TECHNIQUE:

Example: The patient took Picosalax and Dulcolax for bowel preparation and ingested both barium and Telebrix for stool tagging. With a 12F Foley catheter, the rectum was intubated, and the colon was insufflated with carbon dioxide with the patient lying in the left decubitus position. Approximately 1.5 liter were introduced. The patient was then rolled on to their right side and a further 1 litre was introduced. A Scout CT was done to confirm adequate distension of the colon with the patient in the supine position. This was followed by helical scan of the entire colon without any contrast. The patient was then placed in the prone position while carbon dioxide was being insufflated continuously. The CT was repeated as in the supine position.

The following CT parameters were used:

KVP: [K V P]

MAS: [M A S]

Sn. Dose: [DOSE] mGy/cm

CT FINDINGS:

Example: This CT examination has been optimized for colonic polyp detection. As such, it is limited in its ability to detect abdominal abnormalities. The virtual colonoscopy is not sensitive for diminutive polyps (5 mm or less) and these will not be reported as their finding is not considered of clinical significance. Polyps 6 mm or more are reported.

The examination was viewed primarily with 3D reconstruction of the colon as seen through colonoscopy. 2D images were also screened and used for analysis of lesions detected through 3D viewing.

The colon was moderately well prepared and distended.

2D FINDINGS [TWO D FINDINGS]

3D FINDINGS [THREE D FINDINGS]

Appendix 2: C-RADS™ Categorization and Management Recommendations for Colonic Findings

Originally published in *Radiology* at: <https://pubs.rsna.org/doi/full/10.1148/radiol.2361041926>

Table 1: C-RADS™ Categorization and management recommendations for colonic findings

C0	Inadequate study/awaiting prior comparisons Inadequate prep: cannot exclude lesions ≥ 10 mm because of presence of fluid/feces Inadequate insufflation: one or more colonic segments collapsed on both views Awaiting prior colon studies for comparison
C1	Normal colon or benign lesion; continue routine screening ¹ No visible abnormalities of the colon No polyp ≥ 6 mm Lipoma or inverted diverticulum Non-neoplastic findings (e.g. colonic diverticula)
C2	Intermediate polyp or intermediate finding: surveillance colonoscopy recommended ² Intermediate polyp 6–9mm, <3 in number Intermediate findings, cannot exclude polyp ≥ 6 mm in technically adequate scan
C3	Polyp, possibly advanced adenoma: follow-up colonoscopy recommended Polyp ≥ 10 mm ≥ 3 polyps, each 6–9 mm
C4	Colonic mass, likely malignant: surgical consultation recommended ³ Lesion compromises bowel lumen, demonstrates extracolonic invasion

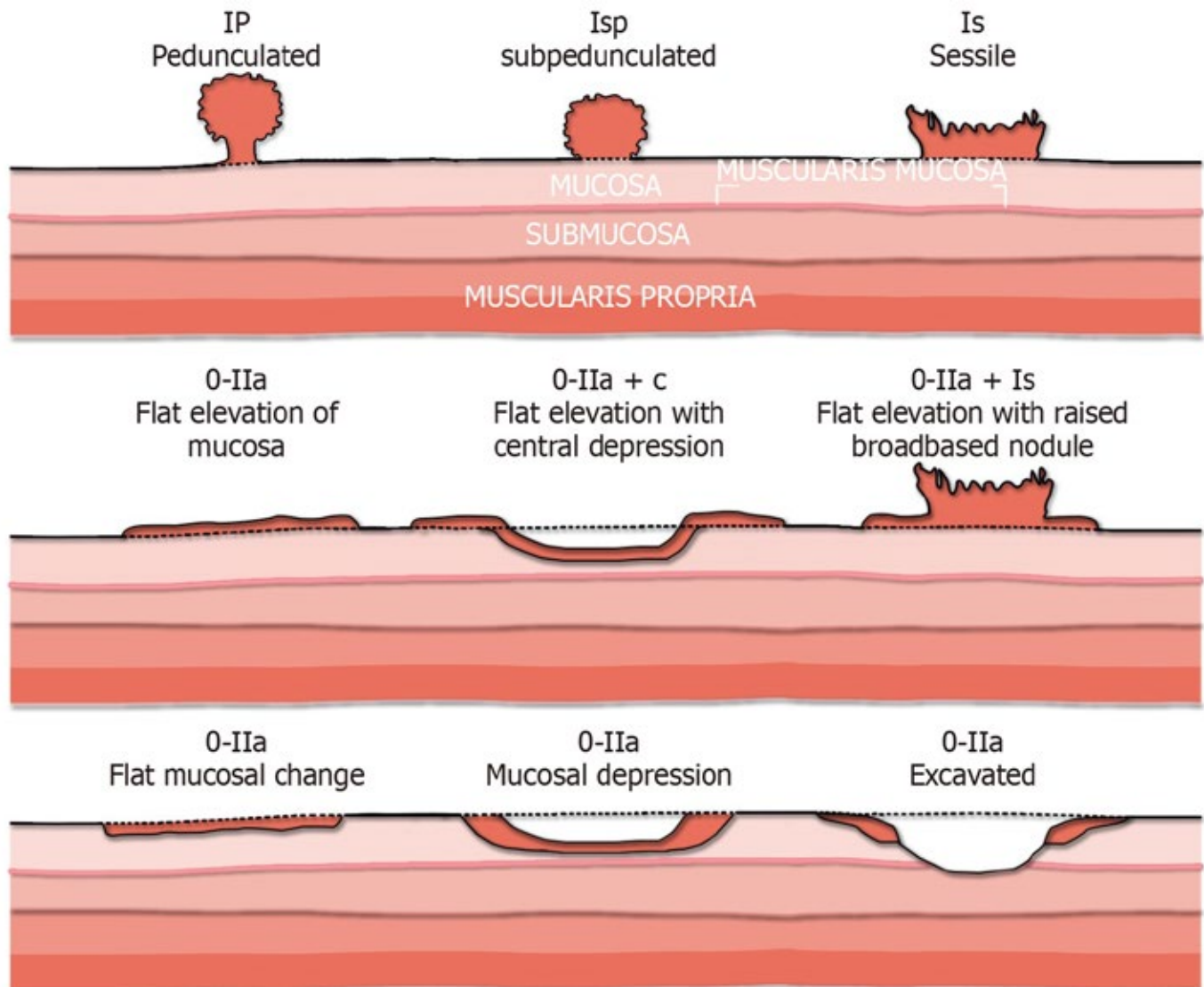
Notes

- 1 Every 5 to 10 years
- 2 Evidence suggests that surveillance can be delayed at least three years, subject to individual patient
- 3 Communicate to referring physician as per accepted guidelines for communication. Subject to local practice, endoscopic biopsy may be indicated.

Table 2: C-RADS™ Categorization and management recommendations for extracolonic findings

E0	Limited examination: Compromised by artifact Evaluation of extracolonic soft tissues is severely limited
E1	Normal results or anatomic variant: No extracolonic Anatomic variant: e.g. retroaortic left renal vein
E2	Clinically unimportant finding: no workup indicated. Examples: Liver, kidney: simple cysts Gallbladder: cholelithiasis without cholecystitis Vertebra: hemangioma
E3	Likely unimportant finding, incompletely characterized: subject to local practice and patient preference, workup may be indicated. Examples: Kidney: minimally complex or homogeneously hyperattenuating cyst
E4	Potentially important finding: communicate to referring physician as per accepted practice guidelines Kidney: solid renal mass Lymphadenopathy Vasculature: aortic aneurysm Lung: non-uniformly calcified parenchymal nodule ≥ 1 cm

Appendix 3: Paris Classification



Reproduced from: Mathews AA, Draganov PV, Yang D. Endoscopic management of colorectal polyps: From benign to malignant polyps. *World J Gastrointest Endosc* 2021; 13(9): 356-370 [PMID: [34630886](https://pubmed.ncbi.nlm.nih.gov/34630886/) DOI: [10.4253/wjge.v13.i9.356](https://doi.org/10.4253/wjge.v13.i9.356)]

Appendix 4: Bowel Preparation Methods

Name of prep	Category (wet vs dry)	Potential side effects and risks	Mechanism of action	Onset of action	Patient tolerance
Magnesium citrate	Dry	Fluid shift from intravascular space Avoid in patients with significant cardiac or renal issues	Osmotic cathartic	Rapid < 30 minutes	Well-tolerated and palatable taste
Polyethylene glycol	Wet	Poor compliance Not optimum for CTC due to residual fluid volumes	Synthetic polymer Encourages fluid to remain intra-luminal (lavage)	30-60 minutes	Poor Large volume (4L) and taste problematic
Picosalax (TM) (active ingredients: sodium picosulphate + magnesium oxide)	Dry	Contraindicated in setting of CHF and significant renal impairment	Stimulant laxative + osmotic laxative	1-1.5 hours	Well tolerated
Bisacodyl	Not used alone but typically in conjunction with cleansing to potentiate the impact of a cathartic. Usually given 6-8 hours before cleansing	Severe diarrhea and electrolyte imbalance	Stimulates enteric plexus and acts as a contact laxative	Can be given orally or as a suppository. Oral 6-10 hrs Rectal: 15-60 minutes	Well tolerated

Appendix 5: Patient-Facing Materials

5a: Appointment Info Sheet for Patients

My CT Colonography Appointment

My Patient Information

{Patient name} {Address} {City} {Postal code} {Phone number}
--

My Appointment Date and Time

{Appointment Date}	{Appointment Time}
---------------------------	---------------------------

If you need to **cancel or rebook** your exam, please notify us at least **5 days in advance**. Please call **xxx-xxx-xxxx ext. xxxx** and leave a detailed message with your full name, appointment date and time. Someone from our booking office will call you to rebook your appointment.

My Appointment Location

{Hospital Name} {Location in hospital} {Street address} {City, Province}	If you have any questions call: {xxx-xxx-xxxx, extension xxxx}
---	--

My To Do List

• Bring your government issued ID to confirm your identity with the medical staff. • Bring any mobility devices you currently require e.g., walker, cane, wheelchair

IMPORTANT

Read the next page for information about what will happen when you have a CT Colonography and what you need to do to prepare.

5b: Exam Info Sheet for Patients

About Your CT COLONOGRAPHY Exam

Computed Tomography Colonography is an exam that uses x-rays to look for polyps or other signs of cancer in the colon. This exam uses a CT scan (CAT Scan) to see your entire colon, instead of using a scope (internal camera). In the exam room, a very small flexible tube is inserted into your rectum to gently inflate your colon with carbon dioxide. This helps to remove any folds in your bowel that might hide polyps from view.

A CT scan is then performed while you are lying on your stomach, and on your back. Occasionally, you will also be scanned on your side. Once the scans are done, the tube is removed. The whole exam is usually completed within 15-30 minutes. After the exam, you can return to your normal activities. You will be awake during the exam.

IMPORTANT

To obtain good images, your bowel must be completely empty.

Your preparation for this exam starts at least 24 hours before your appointment.

Follow the instructions below very carefully. They have been tested to ensure they minimize discomfort while producing a clean bowel. An incompletely clean bowel may mean that the test will have to be repeated. More importantly, if the bowel is not clean, the remaining stool can hide serious conditions that may be present.

5c: One-Day Prep Instructions for Patients

Preparation Instructions for CT Colonography

This document explains how to ensure that your bowel is clear for the exam. It is important that you follow the bowel preparation instructions carefully. If you are not able to follow the instructions, we may NOT be able to complete the test.

If you have any questions or concerns about the instructions below, please contact us at xxx-xxx-xxxx, extension xxx.

One Week Before the Exam

- Purchase a CT Colonography Preparation Kit from the hospital/clinic.
 - A \$XX charge applies.
 - If you have Renal Failure, speak to your Referring Physician. A different preparation may be required.
- Purchase 1 box of Picosalax™ laxative preparation from your local pharmacy*

** If your doctor has asked you remain on a fluid restricted diet, please speak to them about which laxative is best for you.*

Two nights before test (include that date)

- Eat a normal diet up to and including two days prior to test

The Day Before the Exam

You will need to do two things 24 hours before your appointment:

1. Consume only clear fluids.
2. Use the CT Colonography Preparation Kit and Picosalax™. Instructions for this will be contained in this preparation kit.

Clear Fluid Diet

- Gatorade, PowerAde, other sports drinks (red dyes ok to have)
- Water, black coffee, tea (sugar or honey are ok, no cream, no milk)
- Crystal Light, Vitamin Water, iced tea
- Sprite, 7Up, Ginger Ale, Pepsi, Coke
- Bouillon or broth (chicken, beef, vegetable, must be clear)
- Juices (apple, grape, cranberry, lemonade without pulp)
- Jell-O (without fruit)
- Popsicles (not sorbet, not ice cream)
- Clear, hard candies or gum

IMPORTANT TIP

Use of the CT Colonography Preparation Kit and laxative will cause you to have many urgent liquid bowel motions. Stay at home during this day and remain close to the washroom.

You may also wish to use:

- Protective undergarments such as Depends™, etc.
- Petroleum jelly, wet wipes, or hemorrhoid cream to help with possible irritation or burning around the anus.
- Gravol if you feel nausea.

The purpose of the CT Colonography Preparation Kit, laxative and clear fluid diet is to make sure your bowel is clear of solid stool.

Your bowel is empty if there is no SOLID stool in the toilet bowl after you have a bowel motion. Flecks of material are ok. A yellowish colour is also normal. Your bowel movements will not look like “clear fluid” even if your bowel is completely empty.

If you are still passing solid stool on the morning of the test, please tell us and we will advise you how to proceed. (xxx-xxx-xxxx, extension xxxx)

The Day of the Exam

- Do not eat or drink anything on the day of the exam.
- Wear comfortable, loose-fitting clothing to your appointment.
- You do not need to have anyone accompany you.
- Plan to be here for 1-2 hours. The appointment will take approximately 20-40 minutes.
- After changing into a gown, you will lie on a CT scan bed. The Technologist will gently insert a very small, flexible tube three inches into your rectum. Carbon dioxide gas will be slowly pushed into your colon through the tube.
- You will be awake during this process. The gas will create a sensation of fullness, bloating, some cramping, and the urge to have a bowel movement. This is normal and will stop as soon as the exam is over.
- Once your bowel is full of gas, a CT scan will be performed while you are lying on your back, and on your stomach. The Technologist will be in the room with you until the scanning begins. At this point, the Technologist will be able to see, hear and speak with you through an intercom system. Each scan will take less than 5 minutes.
- Once the CT scan is done, the Technologist will remove the rectal tube.

After the Exam

- You do not need to remain in the department after the exam.
- You will not need someone drive you home.
- You can restart your normal diet and activity once you are ready to leave the department. You may restart any medications you have stopped for the exam.
- The bloating and discomfort will disappear shortly after the exam is finished. If you have excessive pain and cramping several hours after the exam, please go to the nearest Emergency room.
- Your doctor will receive a report of the exam results approximately 1 week after the exam.

5d: One-Day Preparation Checklist for Patients

My Patient Preparation Checklist for CTC

On the day of your test, please give this checklist to the technologist completing your exam. The CT Colonography Preparation Kit and the laxative are to be used the day before your appointment.

When	What to Do	✓
One Week Before the Exam		
{Date range}	Purchase: • 1 CT Colonography Preparation Kit from the hospital/clinic* • 1 box of Picosalax™ laxative preparation from your local pharmacy** <i>* If you have Renal Failure, speak to your Referring Physician. A different preparation may be required.</i> <i>** If your doctor has asked you remain on a fluid restricted diet, please speak to them about which laxative is best for you.</i>	
Two Days Before the Exam		
{Date}	Eat a normal diet up to and including two days prior to test	
The <u>night</u> before your preparation day		
{Date}	No solid food after midnight	
PREPARATION DAY or DAY BEFORE YOUR TEST		
{Date} Morning (Breakfast time)	• Pour bottle of EZ-CAT (A) into the large container provided (B) • Top with water and mix well. (You may put it in the fridge, add ice if you like, or leave at room temperature.) • Makes 1 litre • Drink 1 cup (250 mL) of EZ-CAT solution (B) • Drink one packet of Picosalax™ mixed with 1 cup (250 mL) of cold water	
Lunchtime	• Drink 1 cup (250 mL) of EZ-CAT solution (B)	
Mid Afternoon	• Drink 1 packet of Picosalax™ mixed with 1 cup (250 mL) of water	
Dinnertime	• Drink 1 cup (250 mL) of the EZ-CAT solution (B) • There will be some EZ-CAT solution left in the container. You can throw this away	
Bedtime	• Drink the Telebrix (bottle C) with 1 cup (250mL) of clear liquid or ginger ale	
Morning of the Test		
{Date}	• Nothing to eat or drink • Medications with small sips of water only	

Do any of the following conditions apply to you?

I am on a Fluid Restricted Diet

If your doctor has asked you to limit the amount of fluids you drink, please let your doctor know so they can decide which laxative preparation is best for you.

Please call xxx-xxx-xxxx, extension xxxx

I have Severe Constipation

If you have a history of severe constipation that does not respond to use of laxatives, please tell us. You may have to start your test preparation earlier than other patients do.

Please call xxx-xxx-xxxx, extension xxxx

I am Diabetic

Test your blood sugar several times the day before your test, and once on the morning of your test. Your blood sugar should be above 70 mg/dl. If it drops below that, or you have symptoms of low blood sugar, please drink clear fluid with sugar in it. If your blood sugar levels become too low or too high and you cannot bring them back to normal, please go to the nearest emergency room.

I had Diverticulitis 4 weeks before my test

Please call us at xxx-xxx-xxxx, extension xxxx to reschedule your test. You need to allow at least 4 weeks for your bowel to heal before we can complete your exam.

I had a polyp removed during a colonoscopy within the last month

Please call us at xxx-xxx-xxxx, extension xxxx to reschedule your test. You need to allow at least 6 weeks for your bowel to heal before we can complete your exam.

If you take Prescription Blood Thinners or Anti-Platelet Medications

Do not stop taking them unless your doctor tells you to. We can still safely do the test.

5e: Three-Day Prep Instructions for Patients

3-Day Preparation Instructions for CT Colonography

This document explains what will happen when you come to the hospital for a CT Colonography, and how to make sure that your bowel is clear for the exam. This information is important, and **you must follow the bowel preparation instructions carefully**. If you are not able to follow the instructions, we may not be able to complete the test.

If you have any questions or concerns about the instructions below, please contact us at xxx-xxx-xxxx, extension xxxx.

CT Colonography is an exam that uses a CT scan (CAT Scan) to look for polyps or signs of cancer in the colon. A CT scan uses X-rays to see your entire colon, instead of using a scope (internal camera). In the exam room, a very small, flexible tube is inserted into your rectum to allow carbon dioxide gas to gently flow into your colon. The purpose of the gas is to inflate the colon as much as possible to remove any folds in your bowel that might hide polyps from view. The sensation of cramping and fullness during the test is normal and expected. You will be awake during this process.

A CT scan is then performed while you are lying on your stomach, as well as on your back. Occasionally, you will also be scanned on your side. Once the scans are done, the tube is removed. The whole exam is usually completed within 20-40 minutes. After the exam, you can return to your normal diet and normal daily activities.

Three Days before the Exam

- Beginning **three days before your exam**, you will begin to follow the Low Residue Diet. See diet below.
- This diet will last for two days only.
- You will follow the clear liquid diet, laxative preparation, and CT drinks on the day before the exam

Low Residue Diet

- You will start 3 days before your exam and follow this diet for two days
- Limit use of high fat foods (butter, cooking oils, margarine, mayonnaise)
- Avoid foods with skins, membranes, seeds and nuts
- Limit dairy products to 2 servings per day
- Limit meats and alternatives to 2 servings per day
- Limit fiber intake (see recommendations below)

The Day before the Exam

- Consume only clear fluids. Do not eat any solid foods. See clear fluid diet below
- Use the CT Colonography Preparation Kit and Picosalax™ laxative (or generic name, Purg-Odan). There will be two packets of laxative in the box
- Use of the CT Colonography Preparation Kit and laxative will cause you to have many urgent liquid bowel motions that will start 1-2 hours after you begin. Stay at home during this day and remain close to a washroom

You may also wish to use:

- Protective undergarments such as Depends™, etc.
- Petroleum jelly, wet wipes, or hemorrhoid cream to help with possible irritation or burning around the anus
- Graval™ if you feel nauseated

Clear Fluid Diet

- Gatorade, PowerAde, other sports drinks (red dyes ok to have)
- Water, black coffee, tea (sugar or honey are ok, not cream, not milk)
- Crystal Light, Vitamin Water, iced tea
- Sprite, 7Up, Ginger Ale, Pepsi, Coke
- Bouillon or broth (chicken, beef, vegetable, must be clear)
- Juices (apple, grape, cranberry, lemonade without pulp)
- Jell-O (without fruit)
- Popsicles (not sorbet, not ice cream)
- Clear, hard candies or gum

The Day of the Exam

- Do not eat or drink anything the morning of your test.
- You may have medications with small sips of water only.
- You will be asked to arrive 30 minutes before your exam time to allow you to register at our main reception desk.
- Please bring your health card and any mobility devices you may require with you

The purpose of the CT Colonography Preparation Kit, laxative and clear fluid diet is to make sure your bowel is clear of solid stool. Your bowel is empty if there is no SOLID stool in the toilet bowl after you have a bowel motion. Flecks of material are ok. A yellowish colour is also normal. Your bowel movements will not look like “clear fluid” even if your bowel is completely empty.

If you are still passing solid stool on the morning of the test, please tell us and we will advise you how to proceed. Call (xxx-xxx-xxxx, extension xxxx) to discuss.

After the Exam

You will be able to resume your normal diet and daily activities. You are not required to remain in the department after your exam is completed. You will be able to drive yourself home if you wish to do so.

Low-Residue Diet Examples

Category	Limit	Examples
Dairy	Max 2 servings/day; each example is one serving	• 250 ml (1cup) low fat milk • 250 ml (1cup) plain low-fat yogurt • 250 ml (1cup) cottage cheese • 50 g (size of 3 dice) cheese • 250 ml ice cream (1 scoop) (plain, with no fruits or nuts) • 250 ml (1 cup) milk pudding • 250 ml (1 cup) custard
Meat and meat alternatives	Max 2 servings/day; each example is one serving	• One extra large egg (or 2 small eggs): soft/hard boiled, scrambled, poached • 2 Tbsp. creamy peanut butter • Serving size palm of your hand or a deck of cards ground or well-cooked, tender, lean: beef, lamb, ham, veal, pork, poultry, fish, and organ meats
Soups		• Bouillon, broth, cream soups made with allowed ingredients (vegetables, meats, dairy)
Potato and Substitutes	Max 3 servings	• 1/3 cup cooked white rice • 1/2 cup refined white pasta • 1/2 medium boiled, baked, mashed white and sweet potatoes with no skin (max 1 per day) • 1/2 English muffin
Fruits & Vegetables • No skins, membranes, pulp, or seeds • Vegetables should be well cooked	Max 4 servings	• 15 seedless grapes (red or green), no skin • 1 cup fresh cucumber, no seeds • 1 cup iceberg lettuce • 1 cup cubed watermelon • 1/2 cup canned tomato • 1/2 cup cubed honeydew or cantaloupe melon • 1/4 cup applesauce • 1/4 cup cauliflower tips • 1/4 cup celery • 1/4 small banana
Breads and Cereals	Max 4 servings	• 1 slice white refined bread • 6 Saltine Crackers • 1 cup Cornflakes/Rice Krispies
Dessert		• Gelatin, Jell-O, Fruit ice, Popsicles • Plain cakes & cookies made with refined flour • Pie made with allowed fruits & refined flour

5f: Three-Day Patient Prep Checklist

My 3-Day Patient Preparation Checklist for CT Colonography

When	What to Do	✓
3 days before the exam		
{Date range}	Begin the low residue diet	
2 days before the exam		
{Date}	Continue following the low residue diet	
	The CT Colonography Preparation Kit and the laxative are to be used the day before your appointment.	
PREPARATION DAY or DAY BEFORE YOUR TEST		
{Date} Morning (Breakfast time)	- Pour bottle of EZ-CAT (A) into the large container provided (B). Top with water and mix well. (You may put it in the fridge, add ice if you like, or leave at room temperature.) Makes 1litre. - Drink 1 cup (250mL) of EZ-CAT solution (B) - Drink one packet of Picosalax™ (Purg-Odan) mixed with 1 cup (250mL) of cold water.	
Lunchtime	Drink 1 cup (250 mL) of EZ-CAT solution (B)	
Mid Afternoon	Drink 1 packet of Picosalax™ (Purg-Odan) mixed with 1 cup (250mL) of water.	
Dinnertime	- Drink 1 cup (250 mL) of the EZ-CAT solution (B) - There will be some EZ-CAT solution left in the container. You can throw this away.	
Bedtime	Drink the Telebrix (bottle C) with 1 cup (250mL) of clear liquid or ginger ale.	

Do any of the following conditions apply to you?

I am on a Fluid Restricted Diet

If your doctor has asked you to limit the amount of fluids you drink, please let your doctor know so they can decide which laxative preparation is best for you.

Please call xxx-xxx-xxxx, extension xxxx

I have Severe Constipation

If you have a history of severe constipation that does not respond to use of laxatives, please tell us. You may have to start your test preparation earlier than other patients do.

Please call xxx-xxx-xxxx, extension xxxx

I am Diabetic

Test your blood sugar several times the day before your test, and once on the morning of your test. Your blood sugar should be above 70 mg/dl. If it drops below that, or you have symptoms of low blood sugar, please drink clear fluid with sugar in it. If your blood sugar levels become too low or too high and you cannot bring them back to normal, please go to the nearest emergency room.

I had Diverticulitis 4 weeks before my test

Please call us at xxx-xxx-xxxx, extension xxxx to reschedule your test. You need to allow at least 4 weeks for your bowel to heal before we can complete your exam.

I had a polyp removed during a colonoscopy within the last month

Please call us at xxx-xxx-xxxx, extension xxxx to reschedule your test. You need to allow at least 6 weeks for your bowel to heal before we can complete your exam.

If you take Prescription Blood Thinners or Anti-Platelet Medications

Do not stop taking them unless your doctor tells you to. We can still safely do the test.

Appendix 6: Recommended method of colonic distension

- Encourage patient to evacuate prior to the examination
- Insert catheter with the patient in the left lateral decubitus position. Inflate balloon and draw back till resting at anal verge
- Commence insufflation beginning at around 15-20 mmHG increasing slowly to max threshold of 25 mm HG.
- Anti-spasmodic can be given at any point either prior to commencing insufflation or during depending on patient tolerance/preference and /or if insufflation is progressing slowly or appears impeded.
 - We typically give 1 ml (20 mg/ml) of Buscopan™ (Hyoscine n butylbromide) intravenously slowly over 30-45 seconds and flush with normal saline.
 - Or if contraindicated Glucagon™ 1 mg (iv or im)/ml administered slowly over 1 minute to avoid nausea or vomiting .
- The administration of an anti-spasmodic is recorded in the patient chart to ensure no double doses are given however please note it is safe to repeat the Buscopan™ to a maximum dose of 40 mg (in total) in cases where the examination is prolonged or if the first dose has worn off.
- Instill approximately 1.5 l in the left lateral decubitus position, then turn patient to contralateral decubitus (right) and fill a further 1.5-2 liters.
- Turn patient to supine position and acquire scout images
- If satisfactory and uniform distension of the bowel (haustra should be effaced and colonic wall should be imperceptible) then acquire supine dataset in *end expiration*.
- Turn patient into prone position (or decubitus depending on anatomical/patient related factors) and acquire second (or if needed a third data set). Depending on institutional preference routine deflation of the balloon is performed to assist optimal viewing of the anal canal.
- Additional imaging can be acquired as needed.

Appendix 7: Comparison of International CTC Interpretation Training Guidelines for Gastrointestinal Radiologists

International Guidelines						
Metric		BSGAR-RCR (2021) ⁹¹	ESGAR (2013) ⁶	ACR (2019) ²⁵	CAR (2010) ²	RANZCR (2013) ¹¹¹
Performance indicator	Interpretation time	Min > 20 min Asp > 25 min	NS	NS	NS	NS
	Polyp identification rate (PIR)	Min 6 mm + polyps identified in > 13% patients Asp PIR > 16%	NS	NS	NS	NS
	Positive Predictive value	Min > 80% Asp > 90%	NS	NS	NS	NS
	Same day CT staging	Min > 50% Asp > 90%	NS	NS	NS	NS
Training	Training prior to independent reporting	Min > 175 validated cases. Asp > 300 validated cases.	No consensus but recognize that 175 validated cases may be sufficient	Min > 50 validated cases. Training on examination technique, pitfalls	Min > 50 validated cases. Training on technique, anatomy, pitfalls, pathogenesis, epidemiology	Min > 50 validated cases and 10 live cases. Training on technique, anatomy, limitations, pathogenesis, epidemiology
	Interpretation method	Competence in 2D and 3D techniques. Double reading as needed	Competence in 2D and 3D techniques.	Competence in 2D and 3D techniques. Double reading*	Competence in 2D and 3D techniques. Consider double reading*	Competence in 2D and 3D techniques.
	Maintenance of competence	Min > 100/y Asp > 175/y	NS	Supervision and double reading by expert. Testing with feedback 50 cases/y	100 cases/y	30/y (recorded in RANZCR CTC logbook)
	Audit requirement CTC accreditation	Every 2 y No	NS No	NS Contributes to National Radiology Data Registry (NRDR)	'Regular' No	Every 3 y Yes: CTC Specialist Register

BSGAR-RCR: Joint Guidance from the British Society of Gastrointestinal and Abdominal Radiology and The Royal College of Radiologists. Standards of practise for computed tomography colonography; ESGAR, European Society of Gastrointestinal and Abdominal Radiology; ACR, American College of Radiology; CAR, Canadian Association of Radiologists; RANZCR, The Royal Australian and New Zealand College of Radiologists; Min: minimum; Asp: aspirational; NS: not specified.

*Double reading suggested for inexperienced readers.

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